TITLE OF THE INVENTION

Control valve for variable capacity compressor

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a control valve for a variable capacity compressor.

2. Description of the Related Art

It is disclosed in Japanese Utility Model Publication No. 02-37001 to use a bellows pressure response valve as a capacity control valve provided to a variable capacity compressor and the like. The bellows pressure response valve has an advantage in that it is small and that a long pressure responding stroke can be obtained as compared with a diaphragm pressure response valve.

However, in general, it is hard to obtain high straightness in a bellows because of a structure of the bellows. Therefore, if the bellows is winding with respect to a valve lifting direction, a force perpendicular to the valve lifting direction arises when the bellows expands and contracts in the valve lifting direction. As a result, the force perpendicular to the valve lifting direction is transferred to a valve rod to thereby cause an increase in hysteresis in valve opening/closing operation, poor control, and deterioration in a valve opening/closing accuracy.

Therefore, there is a bellows pressure response valve having a bellows as a pressure sensing element and with an airtight structure and transferring expansion and contraction of the

bellows to a ball valve through a valve rod supported to be movable in a valve lifting direction from a valve housing to thereby change a valve opening degree, in which a spherical joint structure formed of an end plate integral with the bellows and a ball is incorporated into a connection portion between the bellows and the valve rod as disclosed in Japanese Patent Application Laid-open No. 2000-88132.

However, according to the above example, because the expansion and contraction of the bellows are transferred to the valve element through the spherical joint structure formed of the ball and the lower patch member, positions of the ball and the lower patch member may be displaced from each other when the bellows expands and contracts and the number of parts increases.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a control valve for a variable capacity compressor, in which positional displacements are prevented by a joint allowing inclination of a joint member and the number of parts is reduced to thereby reduce assembly man-hours.

The invention relates to a control valve for a variable capacity compressor, which comprises a bellows main body retained as a pressure sensing element in a bellows case with an airtight structure and transfers expansion and contraction of the bellows main body in response to a variation in inlet pressure of the variable capacity compressor to a valve element through a valve

rod supported to be movable in a valve lifting direction from a valve housing integral with the bellows case to thereby change a valve opening degree.

According to the invention, in the above control valve, a patch member is provided to a movable-side end portion of the bellows main body and is formed with a fitting recessed portion, a valve rod being fitted to be able to float in the fitting recessed portion, and a compression coil spring is disposed between the patch member and a lower patch member for supporting a fixed-side end portion of the bellows main body.

The control valve according to the invention may take the following forms.

A contact end portion of the valve rod in contact with the fitting recessed portion is in a substantially central position in a bellows expanding/contracting direction of the bellows main body or on the fixed-side end portion side of the central position.

An inner face of the fixed-side end portion of the bellows main body is supported on the lower patch member, an outer face of the fixed-side end portion is supported on an adjusting screw member provided to the bellows case, and a side face of the fixed-side end portion of the bellows main body is supported on an inner face of the bellows case.

A bottom portion of the fitting recessed portion forms a stopper face portion which can come in contact with a stopper face portion formed at a central portion of the lower patch member.

The fixed-side end portion of the bellows main body is

mounted to the lower patch member substantially in the same shape as the patch member, a side face of the lower patch member is supported on a support tube portion formed to stand from the bellows case, and a stopper face portion formed at a central portion of the lower patch member is supported on a support portion extending from an adjusting screw member.

A ball is mounted in the fitting recessed portion and the valve rod is fitted to be able to float in the fitting recessed portion with a lower end of the valve rod in contact with the ball.

With the control valve for the variable capacity compressor according to the invention, it is possible to minimize hysteresis in valve opening/closing operation and to enhance accuracy in the valve opening/closing operation even if straightness of the bellows is somewhat poor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of a control valve according to a first embodiment of the present invention.

FIG. 2 is a vertical sectional view of a control valve according to a second embodiment of the invention.

FIG. 3 is a vertical sectional view of a control valve according to a third embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

First, a control valve according to a first embodiment of the present invention will be described by referring to FIG.

1.

The control valve 10 shown in FIG. 1 is inserted and fixed into a control valve mounting hole formed in a housing of a variable capacity compressor (not shown) as a flow control valve for a flow rate of a refrigerant from a discharge pipe for the refrigerant to a crankcase.

The control valve 10 is formed of a tubular valve housing 11, an end cap 12 mounted to an upper end of the valve housing 11, and a bellows case 13 connected to a lower end of the valve housing 11 by caulking.

An assembly of the valve housing 11 and the end cap 12 is formed of a valve chest 14, a valve port 16 defined by a valve seat portion 15, a first port 17 formed on one side of the valve port 16, a spring receiving seat 23 disposed on the other side of the valve port 16 through the valve chest 14, a second port 18 formed in the spring receiving seat 23, and a valve rod retaining hole 19. The end cap 12 is mounted with a filter 20 for the second port 18 by integral molding.

In the valve chest 14, a ball valve 21 is provided. By movements of the ball valve 21 in a vertical direction (valve lifting direction), a clearance between the ball valve 21 and the valve seat portion 15 changes to determine a valve opening degree. Between a ball receiving member 22 and the spring receiving seat 23 in the valve chest 14, a compression coil spring 24 for constantly biasing the ball valve 21 in a valve closing direction is provided.

At a portion of the valve housing 11 on the side opposite

the compression coil spring 24 with respect to the ball valve 21, the valve rod retaining hole 19 is formed concentrically with the valve seat portion 15. Through the valve rod retaining hole 19, a round valve rod 25 is inserted to be movable in an axial direction (valve lifting direction) of the valve rod retaining hole 19.

A lower end portion of the valve rod 25 is fitted in a fitting recessed portion 31b of a patch member 31 which will be described later. The lower end portion of the valve rod 25 is rounded or formed into a hemispherical shape to form a contact end portion 25a. When the valve rod 25 is lifted, the ball valve 21 opens against a spring force of the compression coil spring 24.

In the bellows case 13, a bellows 26 having an airtight structure is disposed. An inside of a bellows main body 27 is under vacuum. Inside the bellows 26, the patch member 31 and a lower patch member 28 are disposed to face each other. The patch member 31 is provided to a movable-side end portion (upper end portion) of the bellows main body 27 and the lower patch member 28 is provided to a fixed-side end portion (lower end portion) of the bellows main body 27. The lower patch member 28 is disposed inside a bellows main body bottom portion 27b formed of a thick-walled portion at a lower portion of the bellows main body 27 and supports the fixed-side end portion of the bellows main body 27.

Inside the bellows main body 27, a compression coil spring 30 for biasing the bellows 26 in an expanding direction is

disposed in a compressed state between the lower patch member 28 and the patch member 31. The patch member 31 is formed of a base portion 31c in a form of a circular flat plate, the fitting recessed portion 31b formed by sinking a central portion of the base portion 31c deep downward (toward the lower patch member 28), and a large-diameter portion 31d located midway between the base portion 31c and the fitting recessed portion 31b and forming a shallow recessed portion.

The fitting recessed portion 31b of the patch member 31 has such an inside diameter as to allow the patch member 31 to incline with respect to the valve rod 25. A bottom portion of the fitting recessed portion 31b is formed as a stopper face portion 31a. An upper open end 27a of the bellows main body 27 is welded to the base portion 31c of the patch member 31. A lower face of the base portion 31c receives an upper end of the compression coil spring 30. An upper face of the base portion 31c is in contact with the valve housing 11. The compression coil spring 36 which has a small resilient force is arranged between the upper face of the base portion 31c and the valve housing 11.

The lower patch member 28 is formed of a base portion 28c in a form of a circular flat plate and a stopper face portion 28a formed by causing a central portion of the base portion 28c to project upward (toward the patch member 31) and formed on its end face. The stopper face portion 31a formed at the bottom portion of the fitting recessed portion 31b of the patch member 31 and the stopper face portion 28a of the lower patch member

28 come in contact with each other to thereby determine a maximum contracting amount of the bellows 26. A through hole 28b is formed in the stopper face portion 28a of the lower patch member 28 to connect upper and lower spaces partitioned with the lower patch member 28. The base portion 28c of the lower patch member 28 receives a lower end of the compression coil spring 30.

The bellows case 13 is formed with a port 32 and the bellows 26 expands and contracts according to a difference between inlet pressure Ps introduced through the port 32 into the bellows case 13 and bellows internal pressure.

In a lower portion screw hole formed in the bellows case 13, an adjusting screw member 33 is engaged by screwing such that its vertical position is adjustable. With an upper end face of the adjusting screw member 33, the bottom portion 27b of the bellows main body 27 is in contact.

The compression coil spring 30 disposed between the patch member 31 and the lower patch member 28 biases the movable-side end portion of the bellows main body 27 upward, i.e., in such a direction as to separate the movable-side end portion from the fixed-side end portion. As a result, the contact end portion 25a at the lower end of the valve rod 25 and the stopper face portion 31a of the fitting recessed portion 31b of the patch member 31 are maintained in contact with each other. A reference numeral 27c designates a portion where the bellows main body 27 is in contact with and supported on a shoulder portion of the bellows case 13.

The lower end portion (contact end portion 25a rounded

or formed into the hemispherical shape) of the valve rod 25 inserted through the valve rod retaining hole 19 is fitted to be able to float in the fitting recessed portion 31b of the patch member 31 and is in contact with the bottom portion (stopper face portion 31a) of the fitting recessed portion 31b to thereby form a joint structure between the valve rod 25 and the patch member 31. Vertical movements of the patch member 31 due to expansion and contraction of the bellows 26 are transferred to the valve rod 25 and the ball valve 21 through the joint structure.

When the control valve 10 is mounted in the housing of the variable capacity compressor, seal rings S1 and S2 are positioned with the first port 17 therebetween between the housing of the variable capacity compressor and the valve housing 11 to seal out atmospheric pressure from crankcase pressure Pc. Furthermore, between the housing of the variable capacity compressor and the bellows case 13, seal rings S3 and S4 are positioned below the port 32 to seal out the atmospheric pressure from the inlet pressure Ps.

When the control valve 10 is mounted into the variable capacity compressor, if a biasing force of the compression coil spring 30 in the bellows main body 27 exceeds the inlet pressure Ps introduced from the variable capacity compressor through the port 32, the bellows main body 27 expands and the movable-side end portion of the bellows main body 27 and the patch member 31 provided to the movable-side end portion move upward.

Then, the valve rod 25 pushed by the patch member 31 which is moving upward pushes the ball valve 21 toward the end cap

12 against a spring force of the compression coil spring 24. As a result, the ball valve 21 separates from the port 16 to open the control valve 10.

With the above-described joint structure, when the contact end portion 25a of the valve rod 25, rounded or formed into the hemispherical shape, is fitted in the fitting recessed portion 31b of the patch member 31 and is in contact with the bottom portion (stopper face portion 31a), the patch member 31 is allowed to incline with respect to the valve rod 25. The contact end portion 25a of the valve rod 25 and the fitting recessed portion 31b of the patch member 31 are in contact with each other at a center of the bellows main body 27 in an axial direction (expanding/contracting direction of the bellows 26) or below the center (on the lower patch member 28 side). Therefore, as compared with a case in which the contact position is near the base portion 31c of the patch member 31, a lateral movement of the contact position when the bellows 26 winds or the bellows 26 inclines is small. As a result, a lateral displacing force applied to a lower portion of the valve rod 25 is small.

Therefore, with this control valve 10, it is possible to minimize hysteresis in valve opening/closing operation and a highly-accurate control characteristic can be obtained. Moreover, it is possible to enhance durability of the bellows 26 and the valve rod 25.

Next, a control valve according to a second embodiment of the invention will be described by referring to FIG. 2. In FIG. 2, components similar to those shown in FIG. 1 (first

embodiment) are denoted by similar reference numerals.

The control valve 10' of the embodiment is different from the control valve 10 of the first embodiment in (1) a shape of a patch member 31' and (2) shapes of a bellows case 13', a lower patch member 28', and an adjusting screw member 33' for supporting the lower patch member 28'.

With regard to the above difference (1), in the present embodiment, a large-diameter portion 31'd formed in a midway position between the base portion 31'c and a fitting recessed portion 31'b of the patch member 31'is formed to be deeper than the large-diameter portion 31d in the first embodiment. By an amount by which the large-diameter portion 31'd is made deeper, the fitting recessed portion 31'b of the patch member 31' is made shallower. Therefore, a length of a portion of the valve rod 25' to be fitted in the fitting recessed portion 31'b is shorter in this embodiment than that in the first embodiment, with the result that a degree of freedom in inclination of the patch member 31' with respect to the valve rod 25' increases.

With regard to the above difference (2), the lower patch member 28'is formed as a whole in substantially the same shape as the patch member 31'. From the bellows case 13', a support tube portion 13'a extends upward toward the lower patch member 28'.

The adjusting screw member 33' extends to such a position that its upper end comes in contact with a stopper face portion 28'a of the lower patch member 28'. In other words, as shown in FIG. 2, the adjusting screw member 33' includes a

large-diameter extension portion 33'a and a small-diameter support portion 33'b and the extension portion 33'a is fitted and supported in the support tube portion 13'a formed in the bellows case 13'. Furthermore, because an upper end portion (end portion in contact with the lower patch member 28') of the support portion 33'b of the adjusting screw member 33' is rounded or formed into a hemispherical shape, the support portion 33'b of the adjusting screw member 33' can stably support the bellows main body 27 even if the bellows 26 inclines.

According to the embodiment, the fixed-side end portion of the bellows main body 27 is mounted to the lower patch member 28' substantially in the same shape as the patch member 31'. The lower patch member 28' is in contact with a bottom portion of the bellows case 13'. A side face of the lower patch member 28' is supported on the support tube portion 13'a formed to project from the bellows case 13'. Moreover, the stopper face portion 28'a formed to project from a central portion of the lower patch member 28' is supported on the support portion 33'b formed to extend from the adjusting screw member 33'. With these structures, a lower portion of the bellows main body 27 is supported stably.

On the other hand, even if an upper portion of the bellows main body 27 winds or inclines, the valve rod 25 does not receive a force perpendicular to its axial direction because of a relatively flexible joint structure at the lower portion of the valve rod 25' and can move up and down stably.

Next, a control valve according to a third embodiment of

the invention will be described by referring to FIG. 3. In FIG. 3, components similar to those shown in FIG. 1 (first embodiment) are denoted by similar reference numerals.

Similarly to the control valve 10 in FIG. 1 (first embodiment), the control valve 10" shown in FIG. 3 includes as a pressure sensing element the bellows main body 27 retained in the bellows case 13 with an airtight structure and expansion and contraction of the bellows main body 27 in response to variations in the inlet pressure Ps of the variable capacity compressor are transferred to the ball valve 21 through the valve rod 25" supported in the valve rod retaining hole 19 formed in the valve housing 11 integral with the bellows case 13 to thereby change the valve opening degree.

The control valve 10" is similar to the above-described first embodiment in that (1) the patch member 31 is provided to the movable-side end portion of the bellows main body 27 and the valve rod 25" is fitted to be able to float in the fitting recessed portion 31b formed in the patch member 31, (2) the compression coil spring 30 is disposed between the patch member 31 and the lower patch member 28 for supporting the movable-side end portion of the bellows main body 27, (3) a lower face of the fixed-side end portion of the bellows main body 27 is supported on the adjusting screw member 33 provided to the bellows case 13 and a side face of the portion is supported on an inner face of the bellows case 13, and (4) the bottom portion of the fitting recessed portion 31b of the patch member 31 forms the stopper face portion 31a which can come in contact with the stopper face

portion 28a formed at a central portion of the lower patch member 28.

In this embodiment, a ball 40 is disposed to be able to float in the fitting recessed portion 31b of the patch member 31. A lower end portion (contact end portion 25a) of the valve rod 25" fitted to be able to float in the fitting recessed portion 31b of the patch member 31 is in contact with the ball 40. The valve rod 25" is formed to be shorter than the valve rod 25 in the first embodiment by a length corresponding to a diameter of the ball 40. According to the present embodiment, although the number of parts increases, the control valve can be actuated smoothly.

In the control valve 10' shown in FIG. 2 (second embodiment), the ball 40 may be mounted to be able to float in the fitting recessed portion 31'b and in contact with the contact end portion 25a of the valve rod 25'.